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**From:** Steve Willis [steve@uxopro.com]  
**Sent:** 3/3/2017 5:59:41 PM  
**To:** Davis, Eva [Davis.Eva@epa.gov]; d'Almeida, Carolyn K. [dAlmeida.Carolyn@epa.gov]; Dan Pope [DPope@css-inc.com]; Wayne Miller [Miller.Wayne@azdeq.gov]  
**CC:** Henning, Loren [Henning.Loren@epa.gov]  
**Subject:** RE: 2017-3-2 - Williams AFB - FYI - Eleanor Jennings TEC for UXO Pro- sulfate injection perspective - USAF moving EBR forward - response to PMook Feb 10 ST012 -

Thanks, I'll forward. Eleanor's e-mail is [ejennings@teci.pro](mailto:ejennings@teci.pro).

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**From:** Davis, Eva [mailto:Davis.Eva@epa.gov]  
**Sent:** Friday, March 03, 2017 10:50 AM  
**To:** d'Almeida, Carolyn K.; Dan Pope; Wayne Miller; Steve Willis  
**Cc:** Henning, Loren  
**Subject:** RE: 2017-3-2 - Williams AFB - FYI - Eleanor Jennings TEC for UXO Pro- sulfate injection perspective - USAF moving EBR forward - response to PMook Feb 10 ST012 -

I don't know that I have an email address for Eleanor, these need to be forwarded to her — I did my part to make this colorful

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**From:** d'Almeida, Carolyn K.  
**Sent:** Thursday, March 02, 2017 6:13 PM  
**To:** Davis, Eva <[Davis.Eva@epa.gov](mailto:Davis.Eva@epa.gov)>; Dan Pope <[DPope@css-inc.com](mailto:DPope@css-inc.com)>  
**Cc:** Henning, Loren <[Henning.Loren@epa.gov](mailto:Henning.Loren@epa.gov)>  
**Subject:** FW: 2017-3-2 - Williams AFB - FYI - Eleanor Jennings TEC for UXO Pro- sulfate injection perspective - USAF moving EBR forward - response to PMook Feb 10 ST012 -

More comments from Eleanor

Carolyn d'Almeida  
Remedial Project Manager  
Federal Facilities Branch (SFD 8-1)  
US EPA Region 9  
(415) 972-3150

*"Because a waste is a terrible thing to mind..."*

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**From:** Wayne Miller [mailto:Miller.Wayne@azdeq.gov]  
**Sent:** Thursday, March 2, 2017 4:04 PM  
**To:** d'Almeida, Carolyn K. <[dAlmeida.Carolyn@epa.gov](mailto:dAlmeida.Carolyn@epa.gov)>  
**Cc:** steve <[steve@uxopro.com](mailto:steve@uxopro.com)>  
**Subject:** 2017-3-2 - Williams AFB - FYI - Eleanor Jennings TEC for UXO Pro- sulfate injection perspective - USAF moving EBR forward - response to PMook Feb 10 ST012 -

FYI - Some perspective points and opinions provided by Eleanor Jennings (with TEC for UXO Pro, Inc.). Eleanor's comments are in purple and follow Dan Pope and Eva Davis discussion (Feb. 27-28, 2017).

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Excerpted From Dan Pope and Eva Davis (Emails Feb 27-28, 2017)

**From:** Davis, Eva [<mailto:Davis.Eva@epa.gov>]  
**Sent:** Tuesday, February 28, 2017 9:47 AM  
**To:** Dan Pope; d'Almeida, Carolyn K.  
**Cc:** Henning, Loren; Wayne Miller ([Miller.Wayne@azdeq.gov](mailto:Miller.Wayne@azdeq.gov))  
**Subject:** RE: Sulfate Distribution

The figure was just E-21 from the Draft\_Final\_ST012\_RD-RAWP\_Addendum2.pdf.

According to the AF response, *Assuming most of the sulfate is converted to sulfide by the EBR process (removing oxygen mass from quantified TDS concentrations), assuming the sulfide does not precipitate (a conservative assumption)* – in other words, the system will either produce highly toxic H<sub>2</sub>S gas when the sulfide does not precipitate, or the TDS standards will be exceeded by the precipitation of sulfide (I assume with Fe). And of course sulfide is toxic to the bugs as well as Amec crews going around trying to sample wells –

If iron sulfides precipitate, they are removed from the groundwater, and so would not be part of the TDS.

OK, first off, I've dealt with a lot of sites under strong sulfate-reducing conditions, and I've never seen safety issues with monitoring wells. It's not like people are sticking their faces up to the MW pipe and breathing in..... If it's that much of a concern, just bring a gas meter and test the AIR (ie not down in the MW, where you are not sticking your face) as you are testing and monitoring wells. My thought is that AMEC is trying to use safety as an excuse to get out of sampling. Sorry, but people sample anaerobic environments all the time, with no special PPE and no problems.

Second, sulfate-reducers produce sulfide gas all the time, and they live around it all the time. Often, sulfide-oxidizing bacteria are happy to see the sulfide, as it's their source material! These sulfide-oxidizers help keep H<sub>2</sub>S levels in check. I've cultured SRB's in tiny little serum bottles and as long as they had a carbon source, they stayed alive with no problem – and I'm talking for years on end, inside this tiny sealed bottles where the H<sub>2</sub>S had no way to escape. Here in the wide-open environment, the H<sub>2</sub>S is going to quickly dissipate, be used up biologically, or get bound up via abiotic reactions with iron. So I'm having a hard time buying the whole argument that sulfide levels are going to become so high in the environment that the poor, fragile SRBs are going to die off.

The potential problems with sulfide are mentioned by Amec in the work plan, and in various other sulfate reduction publications. Inhibition of sulfate reduction in the absence of iron has been found (Beller et al., Microbial degradation of toluene under sulfate-reducing conditions and the influence of iron on the process, Applied Environmental Microbiology, 58(3):786-793, 1992). Just like they haven't proven that there is a microbial population present that can degrade benzene using sulfate, they also have not shown that there are bugs present that would eat the sulfide that would be produced. So the question becomes is there enough iron present in this system to react with all the sulfate they plan to inject (840 tons, injected at a concentration of 320,000 milligrams per liter)? I don't believe anywhere near this amount of sulfate has been injected at other EBR sites for us to have any idea what will happen under these conditions if the sulfate reducing bugs survive the shock loading.

Sure bugs acclimate (or mutate) to high sulfate concentrations, but what about shocking a system that is used to ~ 300 mg/L with concentrations 100,000 times that? How long will it take for an active population to form? Remember we have like 20 years and something north of 400,000 gallons of jet fuel.

I don't know what the bugs will do, or what bugs are already present, or what the ramp-up time for a useful population would be. They probably could do a lab study which would give an idea, or just start the field effort and find out in a few months or a year. But the idea of injecting high concentrations of sulfate is to get useful sulfate concentrations downgradient of the injection points; eventually, sulfate even immediately around the injection points will be lowered to much lower concentrations.

Yep, if you shock a system with 100,000 times of any component, you're running a risk of killing things off. That's on top of the abiotic reactions that would be occurring. The first step, in my opinion, is to figure out if sulfate is even needed by the indigenous microbes. The next step is to then figure out how much sulfate would be needed and

where. Some basic biogeochemical testing would answer all of this, in under a couple of months (including lab turn-around times). This is why I've been fighting for some basic baseline data to be obtained and properly analyzed.

My understanding is that it's much easier make things grow in a microcosm than in the field, I would think that a proper field test would be a better proposal – although the microcosms might answer the basic question of whether the bugs at this site will even degrade benzene with sulfate.

The ESTCP document we circulated earlier states, *"a practical limit for nitrate or sulfate introduction is around 80 mg/L. . . . the practical limit for sulfate introduction is based on the fact that sulfate reduction can result in the accumulation of sulfide, which is inhibitory to many biodegradation processes."*

High sulfide can be inhibitory to microbes (and human beings!), so that is a potential factor. As far the 80 mg/L "practical limit", Line 344 of the Draft\_Final\_ST012\_RD-RAWP\_Addendum2.pdf indicates that "Historical groundwater monitoring upgradient of site contamination has shown background sulfate concentrations generally range from 250 to 300 milligrams per liter..." so we're well past 80 mg/L already. But all of the potential problems would require significant monitoring and tweaking as the EBR implementation proceeds – which brings us to the next point...

A phased approach to EBR is proposed, in part, to allow for adjustments to be made in response to remediation system behaviors that differ from modeled approaches. Right. Without something very specific in the work plan, Amec will do nothing, just say let's continue to monitor. Even with a well written work plan, there is no guarantee that they will follow it, as we found during SEE. You have admitted also that RPs would rather get stuck in a monitoring phase than to do something active, even when the data doesn't look so promising.

The success of EBR will depend to a large degree on careful implementation, monitoring, and tweaking – as did the "success" of SEE. If the people implementing EBR cannot be depended on to do a good job, then none of comments we provide will make much difference, even if they are incorporated in the workplan.

I agree that AMEC seems to be ignoring instructions, and is instead just doing whatever they want and then asking forgiveness (sort of). This is why, in past documents, I've carefully written guidelines that clearly state what data needs to be obtained and analyzed as baseline data, prior to any implementations. Then, once implementation plans are agreed to, specific monitoring and reporting protocols need to be followed. I think AMEC will need to be watched very carefully, and disciplined hard if they deviate from any agreed-upon plans.

Eleanor, it's doubtful that you have any idea how much Amec has been ignoring instructions, as you haven't been directly involved. They have not asked for any forgiveness.

Certainly I have not covered all the literature on the subject, but I'm not finding anything that says EBR is a good idea when significant NAPL is present.

EBR is not a good idea to deplete large amounts of NAPL of the COCs of interest – unless one has basically unlimited time for the remedy to work. Which is not to say that it cannot possibly work in the short timeframe, but just that it is very highly uncertain. But, if they can actually achieve in three years what Don indicated in the meeting – no LNAPL or sheen in any of the site wells – then that would be very encouraging.

I would like to see them monitor all site wells where LNAPL or COCs have been found in the last five years, as part of the EBR performance monitoring scheme. They can monitor some of those just annually, though, and of course in a final synoptic round to declare success for EBR, and start MNA (assuming success happens, of course).

EBR is good for a polishing step. If NAPL needs to be degraded, it will just take a lot longer. Thus, I agree with the above. The major thing is to implement EBR correctly and not just toss in some sulfate because some random publication mentions this as a solution to some (ie, not all) sites.

Which is why there is no way we should approve addendum 2 without major, major changes to it - if the Region wants to compromise with the AF and let them do something in the field, then I think we could design a field test for them to do, and justify it within the superfund process (part of an FFS, justified at this point because we never approved sulfate EBR, the work plan we approved still did not specify if it would be O2 or sulfate). No way would I go along with giving them 3 years to see if the NAPL magically disappears -- I'm certain Amec could magically disappear in that time.

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